NJDOT Bureau of Research

QUARTERLY PROGRESS REPORT

Project Title:	Correlation between Multiple Stress Creep Recovery (MSCR) Results and Polymer Modification of Binder
RFP NUMBER: 2009-09	NJDOT RESEARCH PROJECT MANAGER: Stefanie Potapa
TASK ORDER NUMBER:RF-CUNY40	PRINCIPAL INVESTIGATOR: Yusuf Mehta
Project Starting Date: 7/1/2009 **Original** Project Ending Date: 09/30/2011 **Modified Completion Date:** 09/30/2011	Period Starting Date: Oct 01 2009 Period Ending Date: Dec 31 2009

Task	% of Total Project Budget	Total Budget	% of Task This Quarter	Cost This Quarter	% of Task to Date	Total Cost to Date
1. Comprehensive Literature Review	10%	$39,893.00	15%	$5,983.89	90%	$35,903.34
2. To conduct MSCR and ER and compare the recoveries measured from both methods, determine the true grade of the modified binders	50%	$199,463.00	5%	$9,973.15	10%	$19,946.30
3. To conduct Gel Permeation Chromatography (GPC) to determine the polymers in the modified binders Also, to conduct Fourier Transform Infrared Spectroscopy and Nuclear Magnetic Resonance Spectroscopy to determine the polymers in the modified binder.	20%	$79,785.00	20%	$15,957.04	20%	$15,957.04
4. Evaluation of Laboratory mixture performance	10%	$39,893.00	0%	$0.00	0%	$0.00
5. To develop appropriate specification limits and the database of mechanical properties of modified binders, mixtures and the type of modification of the binder	5%	$19,946.00	0%	$0.00	0%	$0.00
6. Final Report	5%	$19,946.00	0%	$0.00	0%	$0.00
TOTAL	100%	$398,926.00				$71,806.68

OBJECTIVES:

The objectives of this study are:

1. To determine the challenges and successes of using polymer and crumb rubber modified binder from the existing literature and the state of practice. These include types of polymers, test methods to evaluate polymer modified binder and field and lab performance of mixtures.

2. To conduct traditional Superpave binder tests as per AASHTO M 320 table 1 in order to determine the true grade of binder with various modified binders used in the state of New Jersey.

3. To determine the properties of the polymer modified binders based on table 3 in AASHTO M320 and to determine the recoveries based on the elastic recovery (ER) test.

4. To quantify the molecular weight distributions of polymers present in the binders using Gel Permeation Chromatography (GPC). If necessary, additional tests such as FTIR or NMR will be used to identify and further characterize the polymers.

5. To determine the sensitivity of J_{nr} and percent recovery from MSCR and ER tests.

6. To develop appropriate specification limits and the database of mechanical properties of modified binders and the type of modification of the binder.

7. To provide recommendations to the state of New Jersey on whether parameters from MSCR and ER can be used for the material selection specifications for polymer and CRM modified binders and appropriate specification limits.

BACKGROUND AND RESEARCH PROBLEM:

Currently, the Superpave Performance Grade (PG) binder specification, AASHTO M-320, is used throughout the United States to grade asphalt binders (D'Angelo et al, 2007). This asphalt binder specification was based on a strategic highway research program (SHRP) and was based primarily on the study of neat asphalt binders with no polymer additives. The applicability of this specification to the polymer modified asphalt binders raised concerns by industry and state highway agencies. The inadequacy of the Superpave high temperature specification parameter in Table 1 of AASHTO-M320, $G^*/\sin\delta$, to correctly grade the superior field performance of modified asphalt binders has been demonstrated by several researchers (D'Angelo et al, 2007). Therefore, as a replacement for the existing high temperature binder test ($G^*/\sin\delta$), the FHWA has developed the multiple stress creep and recovery test. This test is used to characterize the asphalt binder high temperature properties at which the pavement has to actually perform, in other words, at the environmental use temperatures. As such, many state DOT's have implemented additional tests called Superpave PG Plus or SHRP Plus tests in an attempt to ensure that a modifier is included in the binder. The SHRP Plus tests do not relate to performance but only indicate the presence of a particular modifier in the binder.

At present, the state of New Jersey requires the use of styrene-butadiene or styrene-butadiene-styrene formulations. In-lieu of the polymer shortages, the state of New Jersey would like to expand the use of polymers and rubber in the binder. Before the state of New Jersey can allow the use of other modifiers**,** there is a need to first determine whether parameters such as the J_{nr} and the recoveries determined from MSCR (and ER) are sensitive to the polymer or rubber modification of the binder**.**

TASK 1 – COMPREHENSIVE LITERATURE REVIEW

A comprehensive literature review of polymer modified binders and their impact on mechanical properties of the binder was conducted. This literature review includes recent studies conducted by Federal Highway Administration (FHWA), State Materials Office, FDOT, University of Wisconsin, Public Works Central Laboratory, Paris, France, University of Texas, Clemson University, South Carolina, Institute for Chemical process and Environmental Technology, Ottawa, Canada, University of Illinois, Texas A&M University and Technical University of Catalonia, Spain. The research team also attended the webcast on how to conduct the MSCR test on September 22nd 2009. Determining the effectiveness of Multiple Stress Creep and Recovery test in characterizing the behavior of polymer modified binders is one of the tasks of this project. All of this is incorporated in the detailed literature review. In addition, the correlation between GPC results and both the physical properties of the binders and the field performance of the pavements from the past research is also documented.

TASK 2. CONDUCT MULTIPLE STRESS CREEP AND RECOVERY TEST

In this study, MSCR test is performed. In the MSCR test, the following is determined.

(a) a minimum recovery percentage at three different temperatures at 3.2kPa shear stress (Table 2) for four different binders; a minimum recovery percentage ensures a sufficient presence of elastic material in the asphalt binder at a high shear stress level.

(b) a minimum ratio of the % recovery at 3.2kPa to the % recovery at 0.1kPa is shown in Table 3. A minimum ratio ensures that the asphalt binder recovery is not highly stress-dependant.

(c)The non-recoverable creep compliance, J_{nr}, is evaluated for the four different binders at three different temperatures as per AASHTO TP-70. The non-recoverable compliance is the non-recoverable strain at each cycle divided by the corresponding stress level used to produce the strain.

(d) In the latest revision of TP-70, the average non-recoverable compliance at 3.2kPa is plotted with the average percent recovery at 3.2kPa tested at the same temperature. The presence or absence of an elastic modifier is determined by where the point for different binders falls on the chart provided in TP-70.

PROPOSED ACTIVITIES FOR NEXT QUARTER BY TASK

- ✓ Determine the true grade of the modified binders.
- ✓ Conduct Elastic Recovery (ER) test.
- ✓ Conduct Gel permeation chromatography (GPC) to determine the polymers in the modified binder.

LIST OF DELIVERABLES PROVIDED IN THIS QUARTER BY TASK

- ✓ Task 1
- ✓ Appendix A: "Comprehensive Literature Review on Evaluation of Polymer Modified Binders with Emphasis on SBS and its Microstructure"
- ✓ Appendix A1: "Gel Permeation Chromatography Analysis of Modified Asphalt Binders"
- ✓ Appendix A2: "Hewlett Packard Series 1100 HPLC Standard Operating Procedure"
- ✓ Appendix A3: "Table A3.1. Complete GPC Analysis"
- ✓ Appendix B: "Determination of the true grade of the modified binders with various modifications used in the State of New Jersey"
- ✓ Appendix B1: "Elastic Recovery (ER) Test"

PROGRESS ON IMPLEMENTATION AND TRAINING ACTIVITIES

Not scheduled

PROBLEMS/PROPOSED SOLUTIONS

Not scheduled

Total Project Budget	$398,926.00
Modified Contract Amount:	$398,926.00
Total Project Expenditure to Date	$71,806.68
% of Total Project Budget Expended	18%

NJDOT Research Project Manager Concurrence: _____ Date: _____

Total Project Budget is the total budget for the multi-year study (e.g. two year total budget).

Modified Contract Amount is the modified total project budget including the original multi-year budget and any additional work approved by the Department.

Total Project Expenditure to Date is the amount billed to date by the University.

% of Total Project Budget Expended is the percentage of the total Project Budget Billed to Date.